

# **DRAFT**

## **An exploration of GOA northern and southern rock sole stock assessment models for 2013**

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### **Introduction**

This document represents an effort to respond to comments made the GOA Plan Team and the SSC on the 2012 assessments of the northern and southern rock sole (*Lepidopsetta polyxystra* and *bilineata*) stocks in the Gulf of Alaska (A'mar et al., 2012). In order to allow for exploration of a wide variety of modeling assumptions, this preliminary overview focuses on model development rather than application of the same model(s) to multiple data sets. Specifically, the model configurations presented here are applied to data through 2012.

### **Comments from the Plan Teams and SSC**

#### ***SSC Comments from the December 2012 Minutes***

*“There were several changes to this year’s assessment model for northern and southern rock sole, and 8 alternative model configurations were presented. Estimated trends in abundance for southern rock sole were relatively insensitive to alternative model configurations. Trends in the early time period of the northern rock sole differed considerably from the southern rock sole. Model 3 was arbitrarily chosen as it presented an intermediate estimate of biomass during the mid-1970’s to mid-1980s for the northern rock sole. The SSC recommends that more formal criteria for model selection be developed and used for northern and southern rock sole.”*

Response: Formal criteria for model selection are being evaluated. The Stock Synthesis software was used for three sets of model configurations as a comparison with the results from the 2012 models, as Stock Synthesis has been validated for stock assessment and its associated tools allow for robust model development and analysis.

### **Summary of the base model configuration**

The base model configuration is the 2012 Model 3 configuration. The software used to run the models presented below was Stock Synthesis v3.24Q as compiled with ADMB v.10.1.

## Model evaluation

### *Model configurations for 2013*

The data used in the model configurations was the fishery and survey data for 1977 through 2012. The survey biomass estimates, length, age, and mean length-at-age data from 1984-1993 are for undifferentiated (aggregated) rock sole, and the data from 1996 on are species-specific. The fishery catch data are for undifferentiated rock sole; the fishery observer length data from 1977-1996 are for undifferentiated rock sole, and the data from 1997 on are for undifferentiated, northern, and southern rock sole. The annual catch time series for the species-specific model configurations is 60% of the annual rock sole catch, as there is uncertainty about what fraction of the annual aggregated rock sole catch is northern and southern rock sole.

Three independent sets of sex-specific model configurations were developed. One set was an aggregated rock sole model configuration which used fishery and survey data for undifferentiated, northern, and southern rock sole; the second set was a model configuration for northern rock sole; and the third set was a model configuration for southern rock sole.

The undifferentiated (aggregated) data model configurations, designated “Urs”, included

- 3 periods of sex-specific fishery selectivity-at-length, 1977-1991, 1992-2001, and 2002-2012, with each period containing at least 10 years of samples;
- 3 periods of sex-specific survey selectivity-at-age, 1977-1995, 1996-2004, and 2005-2012, with each period containing 4 surveys;
- 5 periods of sex-specific growth, 1977-1989, 1990-1995, 1996-2000, 2001-2006, 2007-2012, which allows for the changing ratio of northern to southern rock sole; and
- The selection of estimating natural mortality for males.

The northern and southern rock sole model configurations, designated “Nrs” and “Srs”, respectively, each included

- 1 period of sex-specific fishery selectivity-at-length;
- 1 period of sex-specific survey selectivity-at-age;
- 1 period of sex-specific growth; and
- The selection of estimating natural mortality for males.

## Preliminary results

The results for the “Urs” and “Srs” model configurations were consistent and well-behaved, and had similar patterns to the results from 2012; the results for the “Nrs” model configurations were less reasonable, although the patterns were somewhat similar.

The estimates of total and spawning biomass for “Urs” were higher than those from the 2012 model (Figs. 1 and 2). The estimates of total and spawning biomass for “Nrs” were high at the beginning of the time series, and more similar to those from the 2012 model near the end of the time series (Figs. 3 and 4). The estimates of total and spawning biomass for “Srs” were higher than those from the 2012 model (Figs. 5 and 6). These differences may be due to the differences in the growth parameters, which were estimated in all of the SS3 model configurations.

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	$L$ at $A_{\min}$	$L_{\infty}$	$k$			$L$ at $A_{\min}$	$L_{\infty}$	$k$
2012 N females	16.85	42.43	0.236		2012 N males	17.46	37.95	0.261
SS3 Nrs females	17.70	47.98	0.174		SS3 nrs males	17.20	39.45	0.230
2012 S females	16.64	47.40	0.120		2012 S males	18.09	37.77	0.182
SS3 Srs females	16.32	51.72	0.159		SS3 Srs males	16.29	40.33	0.215
SS3 Urs females #1	14.75	39.44	0.286		SS3 Urs males #1	16.97	30.00	0.393
SS3 Urs females #2	18.22	52.37	0.123		SS3 Urs males #2	17.99	39.70	0.189
SS3 Urs females #3	18.25	50.84	0.155		SS3 Urs males #3	17.74	38.58	0.222
SS3 Urs females #4	16.95	52.06	0.146		SS3 Urs males #4	16.41	40.74	0.202
SS3 Urs females #5	17.18	54.02	0.124		SS3 Urs males #5	16.80	43.47	0.165

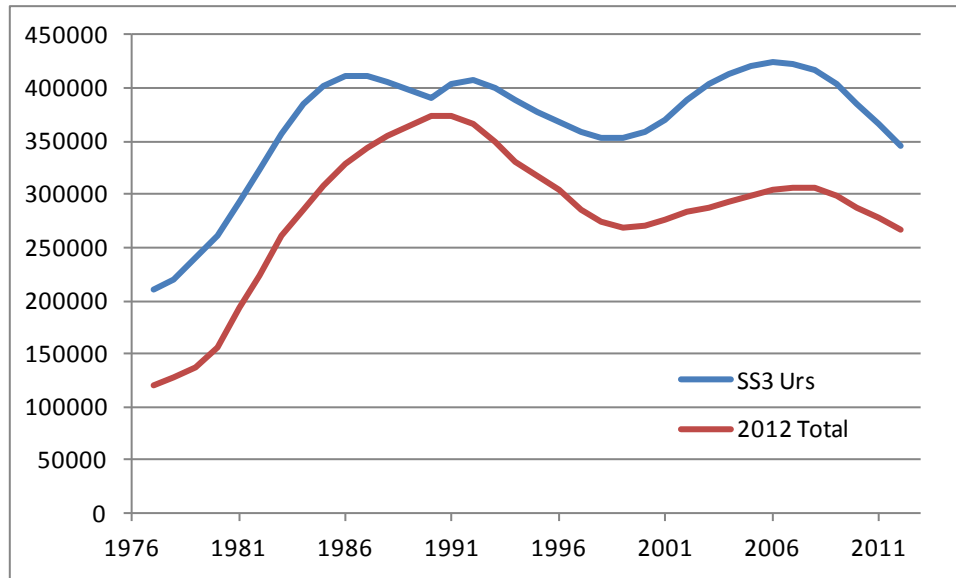
The estimates of the survey biomass indices for “Urs” were an improvement over the estimates from the 2012 model (Fig.7). The estimates of the survey biomass indices for “Nrs” were poor for 1996-2003, and were similar to the estimates from the 2012 model for 2005 on (Fig. 8). The estimates of the survey biomass indices for “Srs” were a slight improvement overall compared with the estimates from the 2012 model (Fig. 9).

The estimates of male natural mortality were consistent across the species-specific model configurations which estimated male  $M$ . The estimates of male  $M$  for “Nrs” were around 0.14 or 0.21, the estimates of male  $M$  for “Srs” ranged from 0.19 to 0.2, and the estimates of male  $M$  for “Urs” were around 0.18 or 0.26, which differ from the fixed value of 0.2 for both northern and southern females.

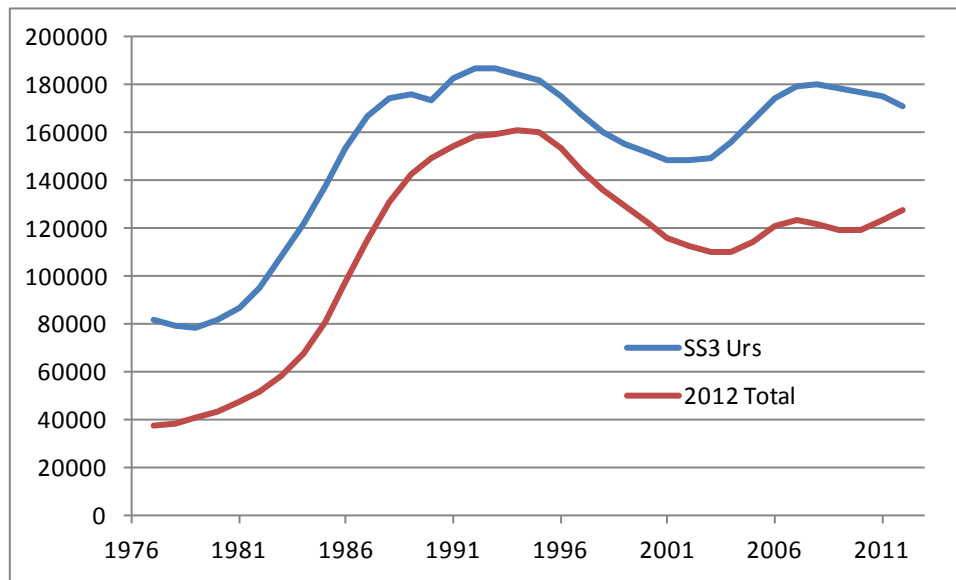
None of results from the three SS3 model configurations presented are from model configurations which estimated male  $M$ . These model configurations were chosen over their counterparts which estimated male  $M$  because these model configurations fit the survey age composition data better and there were minor differences in other categories.

## Figures

**Figure 1 – Estimates of total biomass for undifferentiated rock sole from the SS3 model and the 2012 model**

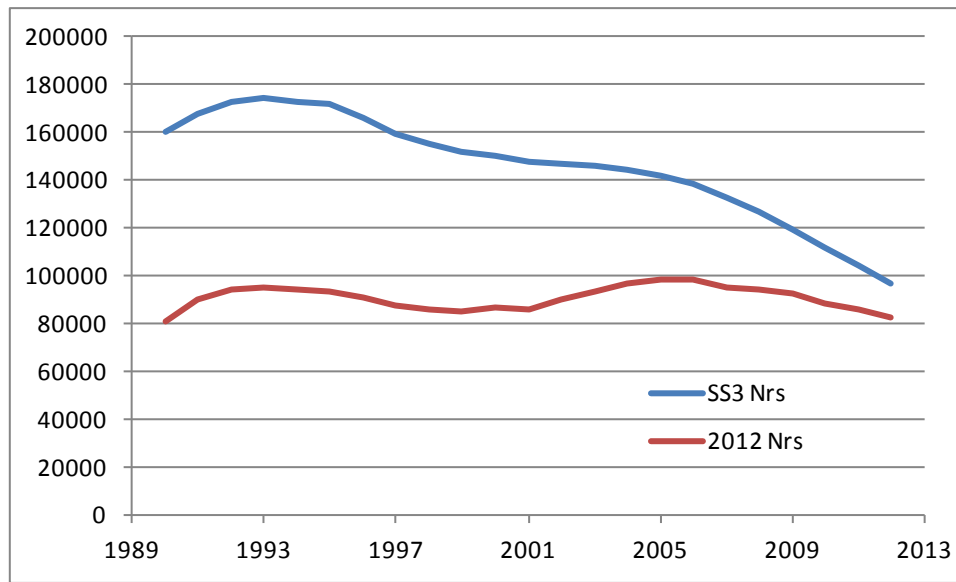


**Figure 2 – Estimated of spawning biomass for undifferentiated rock sole from the SS3 model and the 2012 model**

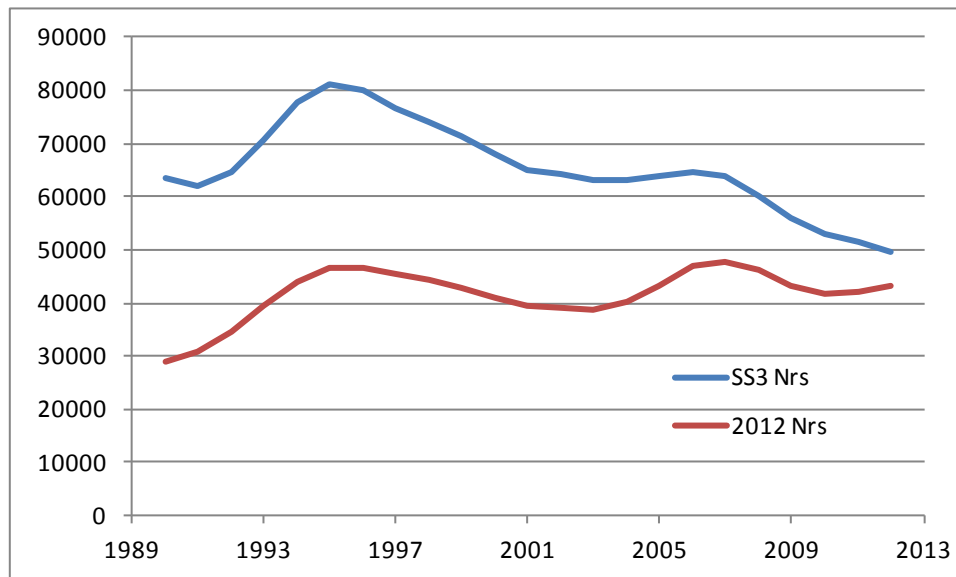


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**Figure 3 – Estimates of total biomass for northern rock sole from the SS3 model and the 2012 model**

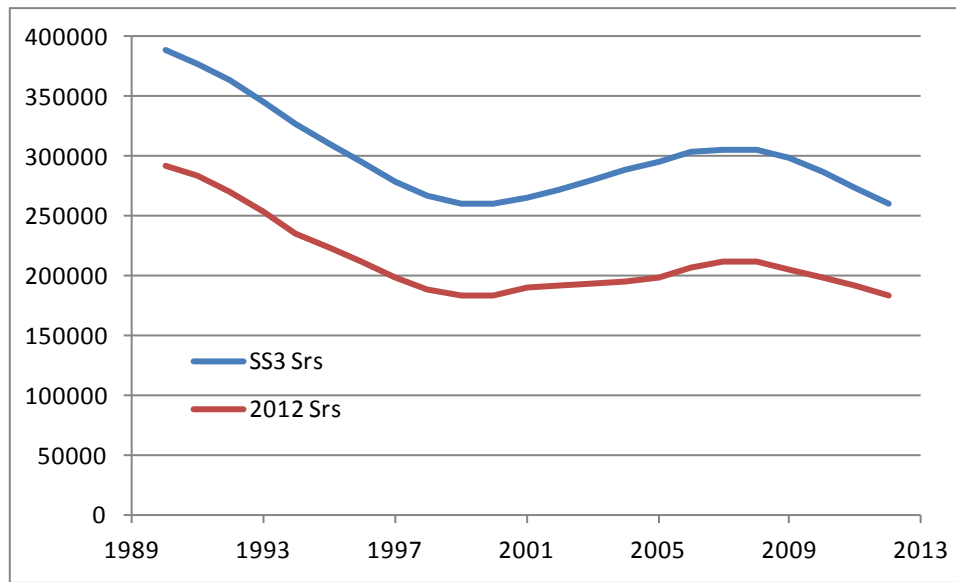


**Figure 4 – Estimates of spawning biomass for northern rock sole from the SS3 model and the 2012 model**

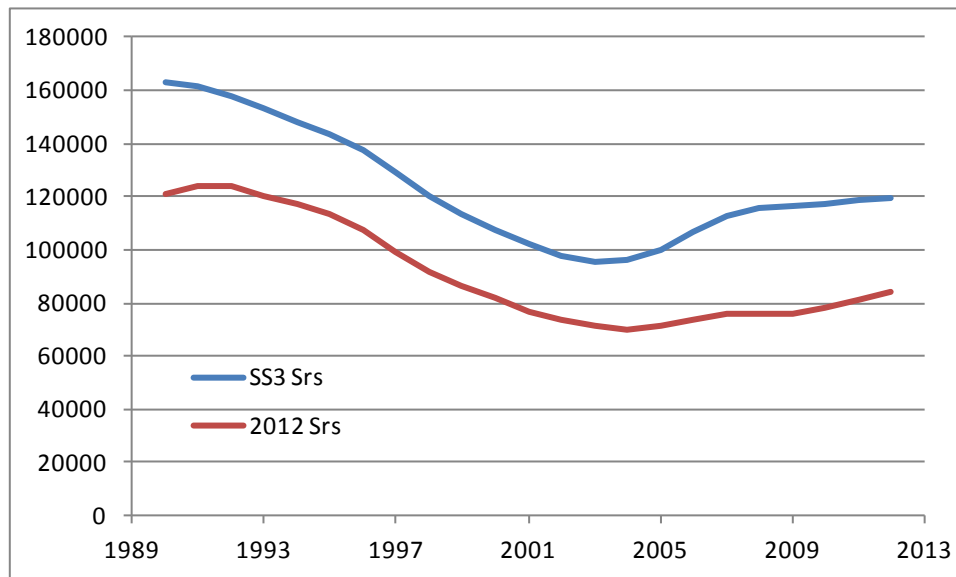


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**Figure 5 – Estimates of total biomass for southern rock sole from the SS3 model and the 2012 model**

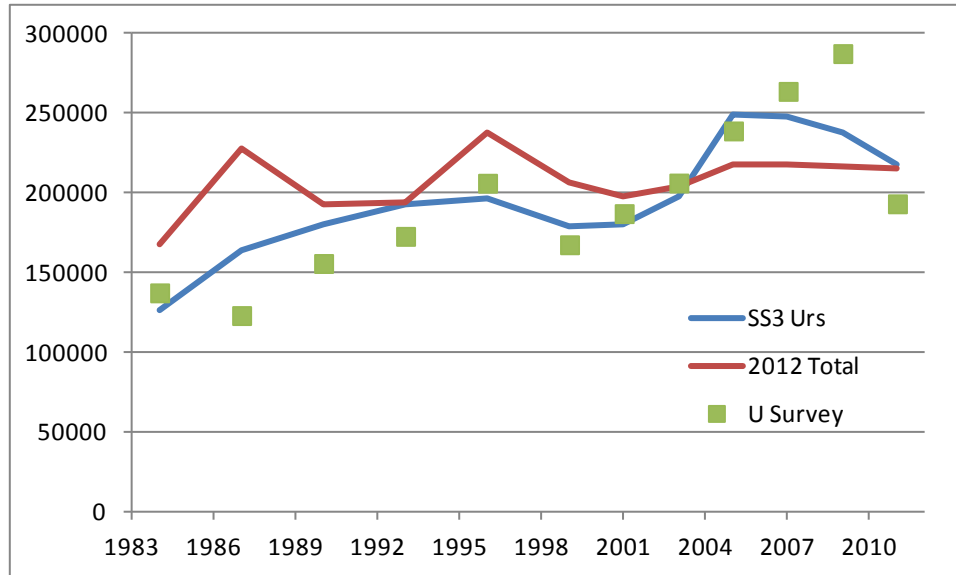


**Figure 6 – Estimates of spawning biomass for southern rock sole from the SS3 model and the 2012 model**

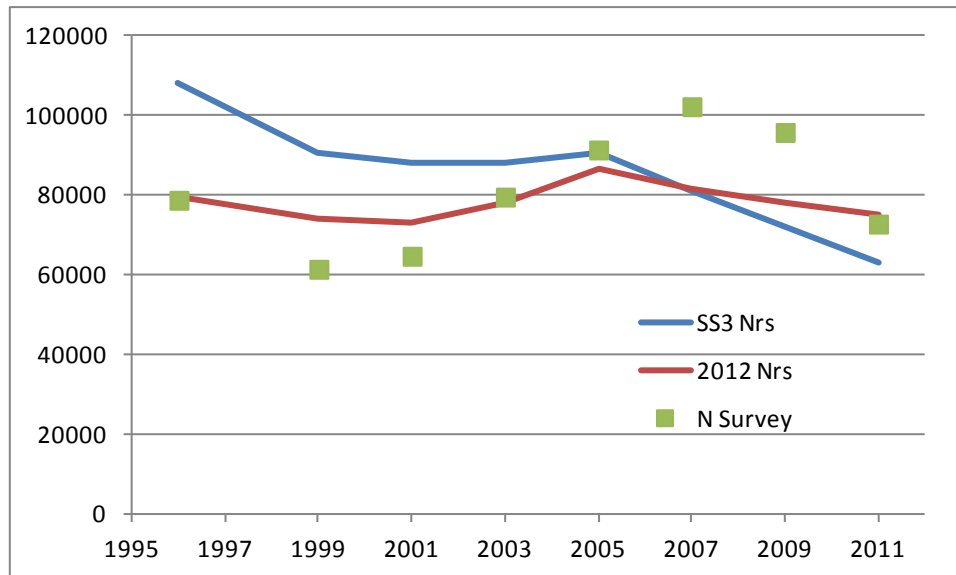


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**Figure 7 – Survey biomass indices and estimates for undifferentiated rock sole from the SS3 model and the 2012 model**



**Figure 8 – Survey biomass indices and estimates for northern rock sole from the SS3 model and the 2012 model**



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**Figure 9 – Survey biomass indices and estimates for southern rock sole from the SS3 model and the 2012 model**

